U. S. Steel Corporation
Minnesota Ore Operations
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October 26, 2016

Mr. John Thomas
Pollution Control Specialist Senior
Compliance and Enforcement Section, Industrial Division
Minnesota Pollution Control Agency (MPCA)
525 Lake Avenue South, Suite 400
Duluth, MN 55802

Re: Monitoring Plan for U. S. Steel Minntac Sulfate Reduction PRB Pilot Test

Dear Mr. Thomas:

Ramboll Environ US Corporation (Ramboll Environ) has prepared a monitoring plan (Plan) on behalf of United States Steel Corporation (U. S. Steel) to monitor a pilot-scale passive in-situ system intended to reduce dissolved sulfate (SO_4^{2-}) in groundwater. The proposed Plan will be conducted in a selected target focus area (hereinafter referred to as the "pilot study area") located across a drainage way at the northeast corner of the Minntac tailings basin. The general site location and pilot study area are presented in the attached **Figure 1** and **Figure 2**, respectively.

PILOT-SCALE TEST DESCRIPTION

U. S. Steel is evaluating implementation of an in-situ permeable reactive barrier (PRB) groundwater treatment remedy that utilizes zero-valent iron (ZVI) and/or addition of organic substrates, in combination with the existing seep collection and return system, as a means to achieve compliance with the 250 mg/L groundwater sulfate standard at its Property boundary near monitoring well MW-12 (also known as the PZ-12 well cluster).

On behalf of U. S. Steel, Ramboll Environ and other contractors have implemented an in-situ pilot study that consisted of two permeable reactive barrier (PRB) test cells spaced approximately 25 feet apart: a Large Diameter Boring (LDB, i.e., southern cell backfilled with 30/70 ZVI/sand), and an array of seven (7) Small Diameter Borings (SDBs, i.e., northern cell backfilled with 40/60 ZVI/sand) to evaluate the reduction of elevated sulfate concentrations in groundwater. The remaining objectives of the original pilot study to be satisfied by this monitoring plan are as follows:

- Develop an appropriate performance and maintenance monitoring program using design considerations and site characteristics;
- Evaluate potential impact of site-specific factors, including extreme temperature conditions on treatment effectiveness; and
- Determine whether a full-scale PRB is appropriate to address long-term compliance at the property boundary.

PERFORMANCE MONITORING PLAN

A shown on **Figure 3**, two new monitoring well nests, composed of 2-inch diameter wells, have been installed just downgradient of the newly installed PRB test cells. REMW-1 and REMW-2 are located just downgradient of the LDB and SDBs, respectively. Each new monitoring well nest contains one shallow, one intermediate and one deep well, screened from 4 to 14 feet below ground surface (bgs), 15 to 25 feet bgs and 38 to 48 feet bgs, respectively. The new monitoring wells described above, the existing upgradient monitoring well cluster PZ-06s/06I/06D and the existing downgradient monitoring well cluster PZ-12s/12I/12D will be used to evaluate performance of the pilot-scale system over time. One monitoring point (MP), screened from 4 to 41 feet bgs, was installed within the LDB. This MP will be used to evaluate conditions within the reactive cell over time.

Groundwater samples will be collected on an approximate quarterly timeframe for the pilot test area, while water level measurements to determine water table elevations will be conducted on a monthly frequency. However, no sampling or monitoring will be conducted during winter months and/or those periods when there is frost in the ground. Comparison of changes in sulfate concentrations over time and distance will provide the primary means of evaluating performance. The sulfate reduction efficiency will be evaluated as a measure of how well the treatment area is able to effectively remove sulfates in groundwater. Concentration vs. distance from reactive cell plots will be developed to illustrate the efficiency. See **Table 1** for a breakdown of sample method and frequency by monitoring well/point.

Table 1: Monitoring Well, Sample Method, and Frequency Matrix

	Total and Dissolved Iron (USEPA Method 6010C)	Sulfate (USEPA Method 300.0)	Sulfide (USEPA Method 376.2)	Dissolved Organic Carbon (USEPA Method 415.1)	Sulfate Reducing Bacteria [1]	Field Parameters [2]	Water Level Measurements
PZ-06s	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
PZ-06I	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
PZ-06D	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
PZ-12s	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
PZ-12I	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
PZ-12D	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
REMW-1-S	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly

Table 1: Monitoring Well, Sample Method, and Frequency Matrix							
	Total and Dissolved Iron (USEPA Method 6010C)	Sulfate (USEPA Method 300.0)	Sulfide (USEPA Method 376.2)	Dissolved Organic Carbon (USEPA Method 415.1)	Sulfate Reducing Bacteria [1]	Field Parameters [2]	Water Level Measurements
REMW-1-I	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
REMW-1-D	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
REMW-2-S	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
REMW-2-I	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
REMW-2-D	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
MP-1	--	Quarterly	Quarterly	--	Quarterly	Quarterly	Monthly

Notes:

[1] Hach Biological Activity Reaction Tests (BART) for SRB. As necessary, quantitative polymerase chain reaction (qPCR) and other biological analyses will be performed based on the Hach BART results.

[2] Field parameters: pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, specific conductivity and field measurement of ferrous iron and sulfide (e.g., via Chemetrics or Hach kits).

The pilot study monitoring is to be conducted for approximately 2 years since winter conditions will prevent collection of samples and may inhibit growth of the SRB community. Therefore, a total of approximately 8 performance monitoring samples are expected to be collected; however, the actual number of samples will be dictated by site conditions and preliminary results of the study.

Hydraulic Monitoring

The two major objectives of hydraulic monitoring are to determine the groundwater velocity through the reactive cell and to evaluate the capture zone of the reactive barriers. Determination of the local groundwater velocity will be required to estimate the residence time of the groundwater in the reactive cells to ensure that sufficient contact time is available to reduce sulfate.

Groundwater potentiometric surface will be monitored on a monthly basis to evaluate changes in hydraulic gradient and direction of groundwater flow which will verify that the test cells are intercepting the target groundwater plume without bypass of sulfate. In addition, vertical hydraulic gradients will be measured to check potential upwelling over the test cells or downward flow beneath the test cells. Water level measurements will not be taken during winter freezing conditions.

QUALITY ASSURANCE, QUALITY CONTROL, AND REPORTING

All field activities will be documented in a field notebook. The information recorded in the notebook will include general site and personnel information, the type of work conducted and the equipment and procedures used. In addition, a description of each sample collected, including the sample number, date and time of sample collection will be included in the field book. All records and data will be maintained for a minimum of five years after the completion of the project. All procedures and sampling techniques will be conducted in accordance with the protocols outlined in the MPCA's July 1997 Water Quality Program Sampling Procedures for Ground Water Monitoring Wells (WQP) dated September 2006.

Equipment shall be thoroughly decontaminated between each sampling point. Hand tools including water level meters will be decontaminated by washing with alconox or equivalent and water followed by rinsing three times with deionized water and air drying. Equipment shall be inspected for remaining particles or surface film, and the cleaning and rinse procedure shall be repeated as necessary. A clean pair of latex gloves shall be used at each new sampling point. Pumps and pump bladders shall be decontaminated by circulating decontamination fluid through the pump after working at each sampling point. Groundwater sampling shall be accomplished using disposable Teflon tubing.

Water quality meters used for any of the sampling procedures described in this Plan shall be calibrated each day prior to use and in accordance with manufacturer instructions by trained field personnel. Equipment calibration and maintenance logs must be maintained for the equipment used during sampling events.

Permanent monitoring wells shall be sampled using MPCA WQP-consistent Low-Flow Purging and Sampling Procedures and a trained technician. Prior to purging, the equivalent freshwater head and the total depth of the well shall be measured and recorded. Water quality parameters including temperature, pH, dissolved oxygen and specific conductance shall be logged by trained personnel using calibrated water quality monitors. Field log entries of samples collected, the time of sample collection, odors, water color and clarity or other pertinent information shall be recorded at the time of sampling.

Samples shall be placed in laboratory provided bottles, preserved as appropriate, and sent to the laboratory under proper chain of custody procedures. Sample bottles shall not be opened until they are ready to be filled.

Quality Assurance/Quality Control (QAQC) samples will be collected in accordance with the WQP (MPCA 2006), as shown in the **Table 2**.

Table 2: QAQC Sampling Type and Frequency

Sample Type	Frequency
Duplicate	One per 10 samples, per matrix.
Field Blank	Once per event, plus one for every additional group of 10 wells.

All samples will be properly labeled, immediately placed in a cooler with ice and submitted to the laboratory within 48 hours using standard chain-of-custody procedures. A state certified laboratory will perform the analysis of samples.

If you have any questions or concerns regarding this matter, please contact me.

Sincerely,

Thomas A. Moe
Environmental Control Engineer
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United States Steel Corporation
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cc: Erik Smith, MPCA
Eric Williams, U. S. Steel
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